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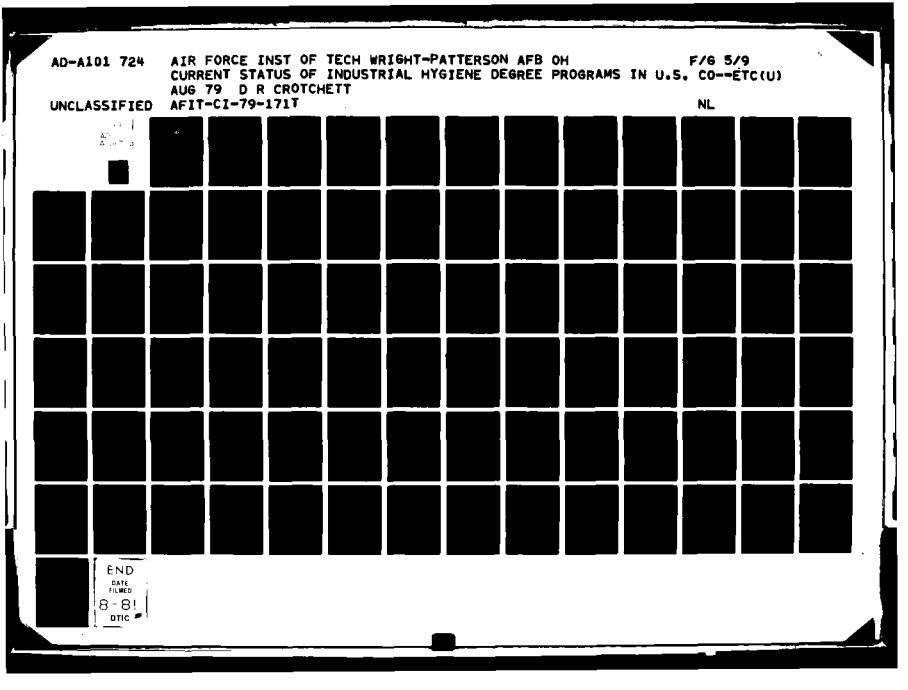

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79-171T

CURRENT STATUS OF INDUSTRIAL HYGIENE DEGREE PROGRAMS IN U.S. COLLEGES AND UNIVERSITIES

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1 Aug 79

(12)

AFIT CI-79-171T

Submitted in partial fulfillment of the requirements
for the Master of Science (Hyg.) degree

Department of Industrial Environmental Health Sciences
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ABSTRACT

The purpose of this investigation was to assess the subject matter being taught to students in professional Industrial Hygiene degree programs and to determine the uniformity of the training received. A questionnaire was developed and mailed to 35 colleges and universities offering graduate and undergraduate degrees in Industrial Hygiene - eleven were returned. The results suggest that there are no uniform admission requirements; however, a strong background in the physical sciences is required by all graduate degree institutions. Insufficient data was received to assess the subject taught under major industrial hygiene topic areas; however, the results suggest that while the institutions are uniform in the topics taught, they are not uniform in the total number of class hours taught in each topic area. The majority of the respondents were in favor of accreditation of industrial hygiene programs, but in view of the limited response no conclusions on a consensus opinion can be drawn. Recommendations for industrial hygiene degree program content and suggestions for future work were also made.

ACKNOWLEDGEMENT

The guidance provided by Dr. Morton Corn during the development, analytical, and summary phases of this project and the excellent professional services provided by Mrs. Mildred Handley in preparing this report are deeply appreciated.

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Current Status of Industrial Hygiene Degree Programs in U.S. Colleges and Universities

I. INTRODUCTION

Since the passage of the Occupational Safety and Health Act of 1970, there has been an increasing demand for industrial hygienists.[2-7] Many colleges and universities are now offering graduate and undergraduate degree programs in Industrial Hygiene and Occupational Health[1] in an effort to meet this demand. Because many of these programs have been developed over the past several years, this investigation was undertaken to assess the subject matter being taught to students in professional industrial hygiene degree programs and to determine the uniformity of the training received.

A literature search was conducted to determine if a similar study had been previously conducted. No such investigation has been done, though several articles have been published on program offerings at individual institutions.[3-5,8,9] One of these articles[8] indicated that 82 industrial hygienists from the rolls of the American Industrial Hygiene Association (AIHA) had been surveyed but only to assess their preference of graduate level instruction in Industrial Hygiene. Additionally, the National Institute of Occupational Safety and Health (NIOSH) had conducted a study for the purpose of forecasting manpower needs and demands.[7] Part of this investigation was a survey of the educational institutions offering associate, undergraduate, and graduate degree programs in occupational safety and health but only to determine the number of students graduated from 1970 to 1976 and to forecast

the number of graduates by 1980, 1985, and 1990. No other current NIOSH publication has investigated industrial hygiene education programs to assess subject matter taught.[10]

II. METHODS

A. Data Acquisition

The data necessary for this report was gathered using a questionnaire designed to inquire into admission and graduation requirements, class hours taught in industrial hygiene subject areas, and to solicit comments about accreditation of professional industrial hygiene degree programs. See Appendix 1 for a copy of the completed questionnaire. The questionnaire was developed using the listed references[11-35] and the personal experience of the author and others queried at the University of Pittsburgh.

Questions were asked about admission requirements to compare minimum academic achievement levels and previous academic backgrounds and experience; graduation requirements to compare units required, length of time required, and stress on design project, Thesis, and report writing; and class hours taught in order to compare academic training in industrial hygiene topics. Additionally, comments were solicited on the academic background most preferred for admission to a Masters level industrial hygiene program, and the desirability of accreditation for educational programs in this field. The accreditation question was included because there was some indication that accreditation may be "needed to maintain the professional nature of industrial hygiene at its present high level and to provide guidelines for those

institutions wishing to initiate quality programs in industrial hygiene."[6]

The major industrial hygiene topics chosen for comparison are listed in Table XI and pages 4 and 5 of the questionnaire (see Appendix 1). The topics were selected to encompass the entire field, which involves recognition, evaluation, and control of industrial hygiene problems. The cover letter accompanying the questionnaire (see Appendix 1) also requested respondents to include, in detail, any topic areas that may not have appeared on the questionnaire. After the major topic areas were chosen, they were further categorized into subject sub-topics. These sub-topics were consolidated into the final questionnaire. Consolidation was necessary to make the questionnaire as short as possible, while still retaining sufficient detail. The detail of the sub-topics included was essential if comparison of instructional subject matter was to be performed.

While this questionnaire was not professionally designed, several requirements of a questionnaire were fully recognized and used during this preparation:

a) The questionnaire should be as short as possible to encourage completion and return;

b) The questionnaire should be easy to complete to encourage respondents to answer all the questions and return;

c) All terms used in the questionnaire should be self-explanatory or be defined.

Because of these requirements fill-in type answers were used instead of essay answers. The sub-topics were consolidated, the term "coursework" was defined, and an addressed, stamped return envelope was included. The term coursework was defined because a major topic may not be taught as one class, but may include bits and pieces from several classes. The term "class hours," next to the topics taught, was considered a self-explanatory term; it requested the number of classroom hours taught in that subject or sub-topic.

B. Questionnaire Recipients

When the questionnaire was completed, the 1977 National Institute for Occupational Safety and Health list of colleges and universities offering undergraduate and graduate degree programs in occupational safety and health[1] was consulted to select institutions which would receive the questionnaire. The NIOSH list included brief descriptions of each program offered and divided the listings into Occupational Safety and Health, Occupational Safety, Industrial Hygiene, Occupational Nursing, and Occupational Medicine. The institutions were selected on the basis of these brief descriptions. See Appendix 3 for all 1977 NIOSH listed institutions. Table 1 is a list of the institutions chosen to receive the questionnaire. Those selected under the Occupational Safety and Health and Occupational Safety categories appeared to have programs leaning toward industrial hygiene rather than safety, education, or program administration. Six out of ten were selected from the Occupational Safety and Health category and 3 out of 27 from the Occupational Safety category.

TABLE 1

COLLEGES AND UNIVERSITIES
SELECTED TO RECEIVE QUESTIONNAIRE

Institution	Degrees Offered: Bachelor	Degrees Offered: Master	Responded to Questionnaire[D]
I. NIOSH Listing: Programs in Occupational Safety and Health			
1. Kansas State University[A]		X	Yes[B]
2. Montana College of Mineral Science and Technology	X		No
3. Pennsylvania State University[A]	X	X	Yes[B]
4. Southern Illinois University[A]		X	No
5. University of New Haven	X		Yes[B]
6. Utah State University	X		No
II. NIOSH Listing: Programs in Occupational Safety			
7. New Jersey Institute of Technology		X	No
8. Texas Tech University		X	Yes[B]
9. University of Wisconsin-Parkside[A]	X		No
III. NIOSH LISTING: Programs in Industrial Hygiene			
10. California State University, Hayward	X		Yes[C]
11. California State University, Northridge	X	X	Yes
12. Central Missouri State University		X	Yes
13. City University of New York, Hunter College	X	X	No
14. City University of New York, York College	X		Yes
15. Colorado State University	X	X	No
16. Columbia University		X	No
17. East Carolina University	X		Yes
18. George Washington University		X	Yes[B]
19. Harvard University		X	No
20. John Hopkins University[A]		X	Yes
21. Purdue University	X	X	Yes[C]
22. Quinnipiac College	X		Yes
23. Saint Augustine's College	X		No

TABLE 1

COLLEGES AND UNIVERSITIES
SELECTED TO RECEIVE QUESTIONNAIRE

Institution	Degrees Offered Bachelor	Master	Responded to Questionnaire[D]
24. Temple University		X	No
25. Texas A&M University	X	X	No
26. Tulane University		X	No
27. University of California, Berkeley		X	No
28. University of Cincinnati		X	No
29. University of Michigan		X	Yes
30. University of Minnesota, Twin Cities		X	No
31. University of North Carolina at Chapel Hill		X	Yes
32. University of Oklahoma Health Sciences Center		X	No
33. University of Pittsburgh		X	Yes
34. University of Washington		X	No
35. West Virginia University		X	No

[A]Listed as "Plans to Offer" in 1977 NIOSH List.

[B]Program not offered in Industrial Hygiene.

[C]Response did not indicate class hours taught.

[D]All institutions not responding are assumed to offer programs in Industrial Hygiene regardless of NIOSH category.

Almost all the colleges and universities under the Industrial Hygiene heading, 26 out of 34, were selected. Those rejected appeared to specialize in one area of industrial hygiene; such as radiation, biomechanics, ergonomics, or industrial psychology; rather than to offer a general program. Institutions were not chosen from either the Occupational Nursing or Occupational Medicine areas.

A total of 35 questionnaires were mailed. Nine went to institutions offering only Baccalaureate degrees, twenty to institutions offering only Master's degrees, and six to institutions offering both. Three weeks after sending the questionnaires a telephone follow-up was made to ensure that questionnaires had been received and to answer any questions or problems related to completion of the questionnaire by the respondent. Eight questionnaires were mailed a second time. Five recipients indicated they did not offer programs in industrial hygiene. The questionnaires were mailed on 9 June 1979. This report is based on questionnaires received up to and including 20 July 1979.

C. Data Analysis

Because the purpose of this report was to assess the subject matter being taught and to determine the uniformity of educational training received, statistical methods showing only central tendency or preponderance of responses are necessary.

Accordingly, for those areas where comparisons between institutions could be made, such as class hours taught, the mean of the respondent's answers, $\bar{X}$, and the sample standard deviation,

S, were calculated. Also, as needed, the mode and range of the response were displayed. For those areas where comparisons between institutions could not be made, such as the acceptance of a student with a previous degree in the major subject area of Chemistry, the number of respondents was listed for comparison with the total number of respondents.

III. EXTENT OF QUESTIONNAIRE RESPONSE

The total response of the returned questionnaires was 46 percent (see Table II). However, when the five institutions not offering industrial hygiene programs (telephone response) and those responses with inadequate class hour data are subtracted from the total, a response of approximately 30 percent was realized. This response represents four institutions out of thirteen selected offering Baccaulaureate degrees and six out of twenty-two selected offering Master's degrees.

The extent of the response to the questionnaires was disappointing. It limits the applicability and extension of the conclusions reached in this report. The conclusions reached are viewed only as suggestive because they are based on what must be considered a limited sample.

IV. RESULTS AND DISCUSSION

A. Admission and Graduation Requirements

The majority of the respondents answered all the questions concerning admission and graduation requirements for their programs.

TABLE II

EXTENT OF RESPONSE TO QUESTIONNAIRE

	Degrees Offered		
	Bachelor	Master	Total
Number of questionnaires sent	15	26	35
Total number responding	8	11	16
Number responding not offering programs	2	4	5
Number responding with inadequate class hour data	2	1	2

	Degrees Offered					
	Bachelor		Master		Total	
	No.	% Total	No.	% Total	No.	% Total
Total response	8/15	53%	11/26	42%	16/35	46%
Response: Institutions offering programs	6/13	46%	7/22	32%	11/30	37%
Response: Adequate class hour data	4/13	31%	6/22	27%	9/30	30%

The original intent in asking the respondent's institution name and address was to ensure the proper address was available for further communications. However, other information covering industrial hygiene education program responsibility and classification, which may affect admission and graduation requirements, is also available from this data. Assuming that the hierarchy of authority and responsibility within an academic institution is university, college or school, department, division, and group; examination of the addresses indicates that the majority of the respondents may have their program responsibility at the departmental level (see Appendix 2 and Reference 1). However, information within this area was not specifically solicited, therefore, conclusions cannot be drawn on actual program responsibility or what effect this may have on admission and graduation requirements.

Information on the classification of responsibility, or type of discipline such as engineering or science, is more readily extracted from the addresses of the recipients and respondents. This data is summarized in Table III. As can be seen, there is no agreement under which classification to place industrial hygiene program responsibility though the majority are listed as relating to "health."

A short section of the questionnaire asked the names, titles, and qualifications of all professors, assistant professors, and instructors teaching industrial hygiene courses. There was some confusion concerning this section because responses were not consistent. Some respondents were explicit in their titles and qualifications and others had minimal responses such as "instructor"

TABLE III

CLASSIFICATION OF PROGRAM RESPONSIBILITY

Classification[A]	Questionnaire[B] Recipients	Questionnaire Respondents
Engineering	3	
Safety Center	1	
Engineering & Science	1	
Science & Society	1	
Science	1	1
Communication & Professional Studies	1	1
Public Services	1	1
Health Sciences	1	
Health Professions	1	1
Veterinary Medicine & Biomedical Sciences	1	
Public Health	7	3
Allied Health & Social Professions	1	1
Hygiene & Public Health	1	1
Engineering & Pharmacy	1	1
Allied Health & Natural Sciences	1	1
Chemistry	1	
Pharmacy	1	
Public Health & Tropical Medicine	1	
Medicine	1	
Health	1	
Public Health & Community Medicine	1	
Physical Education	1	—
TOTAL	30	11

[A]Classification named by institution.

[B]Recipients include respondents.

and "Ph.D." Some respondents indicated the number of years experience, others did not. While the majority of the respondents did not list the area of expertise of each instructor; i.e., chemistry or toxicology, it can be inferred that the expertise available at each institution is not uniform. No information was received indicating if instructors and professors taught full-time or part-time. Some respondents listed only a few teachers, some listed many, and one respondent listed three instructors and noted that members of other department's faculties were used to teach classes in areas of Toxicology, Radiation Health, Computer Sciences, etc. The questionnaire did not ask for detailed information, however, the majority of the professors in the majority of the responding institutions had doctoral degrees (see Appendix 2). Reflecting on this response, it appears that investigation into the professors' expertise, while affecting the program content, would more likely apply to the quality of the academic training received. Inferences about the effects on subject matter taught could probably be made without knowledge of the instructor's backgrounds.

There was no uniform high school grade point average (GPA) requirement among the respondents for those individuals accepted into Baccalaureate degree programs (see Table IV). For individuals accepted into a Master's degree program, most responding institutions preferred a minimum GPA of 3.0; however, there was no agreement on a minimum Graduate Record Examination (GRE) score. Additionally, several comments were received indicating that each individual applicant was considered separately

TABLE IV

ADMISSION REQUIREMENTS
PREVIOUS GRADE POINT AVERAGE AND GRADUATE RECORD
EXAMINATION SCORE REQUIRED

		Number Institutions Responding	
		Bachelor Level	Master Level
Previous GPA:	2.0	3	1
	2.5	1	
	3.0	2	6
TOTAL:		6	7
GRE Score:	1000	-	1
	1050	-	
	1100	-	1
	1150	-	1
	1200	-	1
	Not Listed	-	3
TOTAL:		-	7

and many factors, including GPA and GRE score, were weighed in the acceptance procedure so that it was difficult to state minimum acceptable levels. The Educational Testing Service also cautions on the use of the GRE score.[36] They state that the GRE score should not be used as a sole criterion for admission, combining verbal and quantitative scores can be dangerous, and there may be situations where GRE scores are of little value, such as in the case of previous success in a graduate program. This also implies that a minimum GRE score cannot be set.

Tables V and VI show the previous degrees accepted and preferred by the respondents for admission to a Master's degree program. Comments received indicated that individuals with a strong academic background in the physical or applied sciences and mathematics were generally accepted, with chemistry and chemical engineering backgrounds the most preferred. All institutions may not accept or prefer the same academic backgrounds because of unique requirements of a particular school and the judgement of an Admissions Committee. Additionally, the percentages of students currently enrolled in the respondent's programs show that most have backgrounds in biology and chemistry (see Table V); several comments were received wishing for more applicants with engineering backgrounds. It should be noted that the majority of students currently enrolled have a degree in the least preferred area, biology. However, this is probably a result of the individuals who choose to enter the industrial hygiene career field because all of the responding institutions accept students with a biology background.

TABLE V

ADMISSION REQUIREMENTS: CANDIDATES FOR MASTER'S DEGREE
PREVIOUS DEGREES ACCEPTED

Undergraduate Degree in	Number Responding	Average Percentage of Students in Program
Engineering	6	9%
Chemistry	7	26%
Biology	7	54%
Physics	6	5%
Pre-Med	5	
M.D.	4	
Other	1	16%
Total Number of Institutions Responding	7	-

TABLE VI

ADMISSION REQUIREMENTS: CANDIDATES FOR MASTER'S DEGREE
PREVIOUS DEGREE PREFERRED[A]

Undergraduate Degree in	Number Responding
Any Engineering	3
Chemical Engineering	3
Mechanical Engineering	2
Chemistry	4
Physics	1
Biological Sciences	2
Total Number of Institutions Responding	7

[A] Most institutions selected more than one category as being preferred.

Most of the respondents' programs were arranged around semester academic systems though one bachelor level and two master level programs were based on quarters and one master level program on a trimester system (see Table VII). This variety of academic year systems made it difficult to compare the number of units required for graduation. However, in reviewing the class hour requirement, one credit in any system was equivalent to approximately 15 class hours; therefore, the assumption was made that one credit unit was equivalent regardless of the academic system. Under this assumption, the number of units required for a Baccalaureate degree was consistent ($\bar{X}$ = 130 units, S = 3), with four years allowed to achieve the degree. When the one institution on a quarter system is removed from consideration $\bar{X}$ = 129 and S = 3. A Master's degree required an average of 37 units, with a sample standard deviation of 12, and 1 to 2 years for completion. Examination of the returned questionnaires showed that one Master's program on a quarter system required 64 units and 2 years to complete while the remainder required between 30 and 40 units and 1 to 2 years. When the two institutions on quarters systems are removed from consideration, the number of units required for a Master's degree is also consistent ($\bar{X}$ = 33 units, S = 3).

Table VIII shows that a majority of the respondents do not require a design project at either the bachelor's or master's level. Additionally, a thesis or essay is not required by most of the bachelor's level respondents while five of the master's level respondents do require one. However, all respondents indicate that they stress report writing and make it a required

TABLE VII

GRADUATION REQUIREMENTS:
UNITS[A] AND YEARS REQUIRED

Academic Term:	Bachelor Degree (No. of Respondents)	Master Degree (No. of Respondents)
Quarters[B]	1	2
Semesters[C]	5	4
Trimesters[D]		1
Units Required[E]	$\bar{X}$ = 130 (129) S = 3 (3)	$\bar{X}$ = 37 (33) S = 12 (3)
Years Required	4	1 to 2
Total Number of Institutions Responding	6	7

A: A unit is a credit unit given for completion of required courses. One unit involves approximately 15 hours of instruction.

B: Quarters: Four academic terms per year.

C: Semesters: Two full academic terms plus a summer session per year.

D. Trimester: Three full academic terms per year.

E. Numbers in parentheses indicate $\bar{X}$ and S when institutions on quarter system are not considered.

TABLE VIII

GRADUATION REQUIREMENTS
DESIGN PROJECT, THESIS/ESSAY, AND REPORT WRITING

	Bachelor Degree		Master Degree	
	Required	Not Required	Required	Not Required
Design project	1	5	1	5
Thesis or essay	2	4	5	2
Report writing				
Separate class	1		3	
Incorporated into existing classes	5		4	
Total Number of Institutions responding	6		7	

part of their program, either as a separate class or incorporated into other classes.

All respondents were asked to list academic experience, other than industrial hygiene courses, required for admission to a Master's degree program or required for graduation from a Bachelor's degree program. Information was not requested concerning any requirement unique to a specific program classification, such as engineering or public health; but a variety of topics were listed (see page 3 of questionnaire in Appendix 1). Also information was not asked on the number of disciplines involved in the instruction of these courses. The results are shown in Table IX. The respondents for Baccalaureate programs were also asked to indicate the number of class hours taught in the listed subjects; however, most did not do this. Therefore, comparisons of class hours could not be made among the institutions responding. However, most of the respondents with Baccalaureate programs require algebra, statistics, general and organic chemistry, physics, biology, and the social sciences and humanities for graduation. Respondents with Master's degree programs indicated that academic experience in algebra, analytical geometry, calculus, general and organic chemistry, and physics were generally required for acceptance into the program.

A summary of the admission and graduation requirements of both graduate and undergraduate industrial hygiene degree programs suggests that there is no uniformity in admission requirements among the academic institutions. A summary also suggests that while the number of units and length of time required for a

TABLE IX

ACADEMIC EXPERIENCE

MASTER'S DEGREE PROGRAM ADMISSION REQUIREMENTS AND BACHELOR'S DEGREE PROGRAM GRADUATION REQUIREMENTS

Subject	Number Responding: Bachelor's Degree Graduation Requirements	Number Responding: Master's Degree Admission Requirements
Engineering: Industrial Operations	2	0
Mathematics:		
Algebra		6
Analytical Geometry	2	4
Calculus	1	5
Probability Theory	2	1
Statistics	4	1
Chemistry:		
General	5	6
Organic	3	5
Physical	1	1
Analytical	0	3
Biochemistry	1	1
Physics	5	6
Biology	4	3
Microbiology	4	2
Anatomy	5	0
Physiology	5	2
English	5	2
Speech	4	0
Report Writing	5	1
Social Sciences	4	1
Economics	5	1
Humanities	5	1
Psychology	2	0
Total Number of Institutions Responding	5	6

degree may be uniform, the subject matter taught, at least in Baccalaureate programs, is not. The next section of this report on class hours taught in industrial hygiene subjects should provide more insight into this matter. Lack of uniformity in admission requirements should be expected for several reasons. Among these reasons are that not all institutions provide the same quality of education; the students applying for admission do not have equal levels of interest, ability, and ambition; and the type of discipline; i.e., engineering, medicine; may have unique requirements because of their program classification. It may be that institutions with reputations for high quality and easy placement of graduates attract those students of higher caliber and are, therefore, able to set higher admission standards. However, it is not part of the American education system to strictly limit those people in a particular professional career to those of the highest ability; and, therefore, admission requirements vary providing opportunity for all who are interested. Additionally, many educational institutions are supported by state tax dollars and face requirements from state governments to admit any state resident graduating from a state high school, regardless of the student's high school GPA. This will cause a difference in admission requirements between tax supported and privately funded institutions.

The suggested lack of uniformity in Baccalaureate degree graduation requirements may be the result of the quality of the offered program, the lack of guidelines as to the content of a professional industrial hygiene degree program, and any special undergraduate requirements unique to that program's classification.

The quality of any educational program depends upon many factors among which are the backgrounds and expertise of the professors and instructors and the availability and state-of-the-art of the facilities and equipment used for instruction. If the expertise and equipment are not available, for instance in the area of Anatomy, then this subject will probably not be taught. However, the fact that a subject is not taught may also be caused by a lack of guidelines on course content. With no guidelines, each individual institution must make decisions on the minimum requirements of which industrial hygiene and other subjects to teach. These decisions will affect which "core" or background courses are taught. For instance, if a course in aerosols is not taught then the "core" courses of calculus and organic chemistry may not be taught and the course content of both general chemistry and physics may not be as extensive. The courses listed in Table IX may be considered "core" courses and, therefore, for the above reasons, the lack of uniformity among subject matter taught in Baccalaureate degree programs may be expected.

Since the purpose of this report was to investigate the subject matter being taught, information relating to the quality of the educational training received is not necessary. If an investigation into the quality of the industrial hygiene programs offered by the various institutions was conducted, then detailed questions would have to be asked on the program responsibility and classification, professors' expertise, number of disciplines involved (engineering, medicine, physical science, etc.) and which classes they teach, and equipment and facilities available.

One last area of the graduation requirements should be addressed. This is the requirements for a design project, a thesis or essay, and report writing. It is encouraging to note that all responding institutions stress report writing since work in the industrial hygiene career field invariably involves communications with other functions, organizations, industries, and governments. These results also suggest that all institutions offering degree programs in industrial hygiene may place a similar stress on report writing. However, those institutions not requiring a design project or a thesis/essay may have another deficiency in their programs: There may be no method of binding together subjects taught in industrial hygiene to focus on the understanding of and solution to a problem. Single subjects, when taught, may include the solving a problem in that subject, but these problems are necessarily limited in scope. The overall understanding of and solution to an industrial hygiene problem may involve the understanding of aerosol generation, physiology of respiratory and cardiovascular systems, toxicology, industrial operations, psychology, exhaust ventilation systems, air cleaning, and waste disposal to recognize, evaluate, and control. The requirement for either a design project or thesis/essay could present the student with such a problem so that he would end up with a better understanding of how all areas of industrial hygiene topics interact.

B. Class Hours Taught in Industrial Hygiene Subjects

The questionnaire, as developed, was very detailed and divided each major topic area into sub-topics. It was hoped

that the respondents would indicate class hours taught in each sub-topic so that a detailed comparison could be made. However, the respondents only indicated total class hours taught under each major topic and most did not indicate which sub-topics were covered. There was some confusion about what was meant by "class hours taught" and several respondents indicated credit hours for that course. In these cases, an assumption was made that each credit unit was worth 15 classroom hours with no allowance made that 1 credit of "laboratory" work involves more classroom time than does 1 credit of "lecture." Therefore, the only comparison that can be made is for total hours taught under one subject, such as Aerosols, without any comparisons of the materials actually focused on. None of the respondents added any topics to the questionnaire, nor were any comments received that a particular topic should not be taught.

Respondents were asked to indicate which classes, out of 20 topic categories, were optional, required, or not taught. This data is summarized in Table X. Those courses most frequently optionally offered by the majority of the respondents are Water Pollution, Radiation, Occupational Safety and Health Law, and Ergonomics/Anthropometry. Those classes most frequently not taught are Occupational Medicine, Ergonomics/Anthropometry, and Lighting. Data was not solicited on the reasons for these courses being optionally offered or not taught, but it is suspected that it may be caused by lack of teaching expertise available or to tailor the programs to fit the required number of units.

Several respondents grouped more than one topic under the number of class hours taught and one respondent grouped every-

TABLE X

NUMBER OF OPTIONAL COURSES
AND COURSES NOT TAUGHT

Number of Courses[A]	Number of Institutions With		
	Optional Courses	Courses Not Taught	Both Optional and Not Taught
0	3	2	1
1	3	3	-
2	2	3	4
3	-	2	-
4	1	-	3
5	-	-	1
6	-	-	-
8	-	-	-
9	-	-	-
10	-	-	-
11	-	-	-
12	1	-	-
13	-	-	1
No Indication	1	1	1
Total Number of Responding Institutions	11	11	11

NOTE A: Total number of course topic categories is 20.

thing from "Radiation" through "Aerosols, Gases, Vapors and the Respiratory Tract" together. Because several of the respondents indicated that it was difficult to separate the sampling, analyses, and equipment calibration laboratories, these three were grouped into a single comparison category for this report. Several respondents also indicated total class hours for ionizing and non-ionizing radiation and several indicated them separately. These topics were also grouped under a single comparison category even though several respondents indicated they did not teach non-ionizing radiation. Several respondents indicated that some subjects were covered in other classes, such as Air Flow Measurement being taught in the Sampling, Analyses, and Equipment Calibration laboratories or the subjects in Occupational Medicine being taught in Toxicology, but did not list separately the hours taught. One respondent indicated that the subjects of Industrial Safety and Occupational Medicine were combined into a single class and listed the total number of hours taught. Additionally, one respondent listed that six hours were taught in Air Flow Measurement and Ventilation Design which could be interpreted to mean that the class was mostly on air flow measurement and the description of exhaust ventilation systems; and another respondent indicated that only Air Flow Measurement was taught.

Because of the lack of detailed and uniform responses, it was decided to display the number of respondents and the mean, sample standard deviation, mode, and range of class hours taught in Table XI. This investigation sought information on the hours of classroom instruction in each topic being taught; therefore, the mean, mode, and range of hours do not include any "0" hour

TABLE XI

CLASS HOURS TAUGHT

Subject	Bachelor's Degree					Master's Degree				
	Number (A)	$\bar{X}$ (Hours)	S (Hours)	Mode (Hours)	Range (Hours)	Number (A)	$\bar{X}$ (Hours)	S (Hours)	Mode (Hours)	Range (Hours)
Biostatistics	5	45	0	45	(45)	6	47	14	45	30-70
Epidemiology	5	41	8	45	30-45	6	46	9	45	33-60
Anatomy/Physiology	5	49	8	45	45-60	6	52	45	45	7-135
Toxicology	5	34	22	45	2-45	6	38	10	45	22-45
Ergonomics/Anthropometry	1	3	0	3	(3)	4	37	10	45	27-45
Occupational Safety and Health Law	5	26	21	-	3-45	5	38	10	45	24-45
Industrial Safety	5	30	15	-	15-45	6	40	20	45	16-75
Occupational Medicine	2	3	0	3	(3)	4	37	14	45	16-45
Radiation	5	47	3	45	45-51	6	36	27	-	3-72
Lighting	5	4	2	-	2-6	4	4	3	-	1-6
Noise	5	18	23	-	3-45	6	19	14	-	6-31
Respiratory Protection	5	6	5	-	1-10	5	4	1	3	3-6
Heat and Cold Stress	5	5	4	-	2-10	6	6	2	8	3-8
Air Flow Measurement and Ventilation Design	5	18	24	-	2-45	6	36	15	45	6-45
Aerosols	5	26	22	-	2-45	6	50	21	45	27-75
Aerosols, Gases, Vapors and the Respiratory Tract	5	21	22	-	2-45	6	23	19	-	6-48
Sampling, Analyses, and Equipment Calibration Laboratories	5	73	48	-	18-110	6	106	51	90	60-197
Air Pollution/Air Resources Management	4	45	0	45	(45)	6	39	16	45	6-45
Water Pollution/Water Resources Management	4	56	23	45	(45)	5	57	25	45	45-102
Organization and Management of Industrial Hygiene Programs	4	26	22	-	2-30	6	32	26	-	4-75
Total Number of Institutions Responding	5	-	-	-	-	6	-	-	-	-

NOTE A: Number means the number of institutions responding to the questionnaire and indicating that subject matter is taught as an optional or required course.

indications for respondents who do not teach a particular class. Also, because of the subject matter groupings and lack of class hour indications, as discussed above, the statistics shown in Table XI were, in some cases, compiled from fewer institutions than listed in the "Number" column.

With very few exceptions, the responding institutions are not uniform in the number of hours taught in industrial hygiene subjects at either the Baccalaureate or Master's degree levels of instruction. However, it is interesting to note that, with few exceptions, the majority of the responding institutions instruct in all of the topics listed in the questionnaire. There are five exceptions to non-uniformity at the Baccalaureate level: Biostatistics, Epidemiology, Anatomy/Physiology, Radiation, and Air Pollution/Air Resources Management. The majority of Baccalaureate programs do not contain instruction in Ergonomics/ Anthropometry or Occupational Medicine. At the Master's degree level there is only one exception to the non-uniformity characteristic, Respiratory Protection; and all topics are taught by the majority of the respondents.

When the list of major topic areas is reviewed (see Table XI or Appendix 1), only two topic headings immediately suggest engineering control of industrial hygiene problems, Ergonomics and Ventilation Design. However, when the subject subtopics, listed in the questionnaire (see Appendix 1), are reviewed, it is noted that engineering control methods are listed under Radiation, Lighting. Noise, Ventilation Design, and Air Pollution. Engineering controls methods could also be involved in the subjects

of Heat and Cold Stress, Industrial Safety, and Water Pollution. Since insufficient data was received from the respondents, a comparison of the class time devoted to each basic area of industrial hygiene; recognition, evaluation, and control; cannot be made.

Conclusions drawn from the above discussion would suggest that while material within each major industrial hygiene topic is taught by those institutions offering Baccalaureate and Master's degree programs, there is no uniformity on the amount of time spent on each topic. There may be several reasons for this, among which are the lack of guidelines and the expertise available at a particular institution, as discussed previously. While it is encouraging to note that instruction is offered in the major topic areas, it is also disappointing that insufficient data was received to pinpoint which subject sub-topics are focused on.

C. Accreditation of Industrial Hygiene Degree Programs

The last topic covered by the questionnaire asked for comments on accreditation of Industrial Hygiene degree programs by some organization such as The American Industrial Hygiene Association (AIHA) or the American Board of Industrial Hygienists (ABIH). The majority of the respondents were in favor of accreditation procedures (see Table XII), however, it should be noted that each response is probably the personal opinion of the individual filling out the questionnaire. Because only a very small number of all industrial hygienists were surveyed by this study for their

TABLE XII

ACCREDITATION PREFERENCES

For	7
Against	2
Abstain	1
No Response	1

Total Number of Institutions Responding - 11

opinions on accreditation, no conclusions can be drawn about the general desirability/undesirability of having academic degree programs in Industrial Hygiene accredited. Comments received from those in favor of accreditation indicated that it was needed to control the quality of the academic programs. Comments received from those against accreditation indicated that it would not allow the academic institutions enough flexibility to meet the needs of their students and society; they could not afford to get involved in the politics of some accrediting association or organization. One respondent, who abstained from a preference, indicated that accreditation had its good points, in that it would provide uniformity among the programs offered, and its bad points, in that it may hinder progress and not provide enough flexibility. However, this respondent stated that it would depend on the goal of the accreditation procedure and not the need for it. Additionally, one respondent in favor of accreditation expressed reservations about the accreditation procedure unless the academic institutions had a voice in establishing it. Organizations suggested by the proponents of accreditation, to oversee the procedures, included the AIHA, ABIH, American Academy of Industrial Hygienists, The American Public Health Association, and an independent body of industrial hygienists representing all facets of the field. One respondent indicated that it did not matter what organization established the accreditation criteria as long as it was approved by the U.S. Department of Health, Education, and Welfare; Office of Education; Division of Eligibility and Agency Evaluation; Accrediting Agency Evaluation Branch.

V. SUMMARY AND CONCLUSIONS

The purpose of this study was to assess the subject matter being taught to students in professional Industrial Hygiene degree programs and to determine the uniformity of the training received. A questionnaire was developed and mailed to 35 institutions offering Baccalaureate and Master's degrees in Industrial Hygiene. Because of the limited response conclusions reached by this investigation are only suggestive and may not be widely applicable. However, these conclusions are:

A. There may be no uniform admission requirements for entrance into either Bachelor's or Master's degree programs in Industrial Hygiene.

B. The number of credit units and length of time required to obtain either a Bachelor's or Master's degree may be consistent among the academic institutions offering programs in Industrial Hygiene when similar academic terms are compared.

C. Admission to Master's degree programs will probably require a strong background in the physical sciences and some mathematics.

D. Graduation from a Baccalaureate program should probably require courses in mathematics, the physical sciences, and social sciences and humanities.

E. While the majority of institutions with degree programs in Industrial Hygiene probably teach subject matter in the major i dustrial hygiene topics, there is probably no uniformity in the number of class hours taught in each area.

F. While the majority of the respondents preferred that colleges and universities offering programs in Industrial Hygiene be accredited, no conclusions can be drawn about the general desirability for accreditation.

G. Because of insufficient data received, no comparisons can be made on the specific subject matter under each topic and, therefore, no determination can be made if graduates are receiving comparable academic training.

The results of this investigation partially answered one of the objectives of this study, the uniformity of the educational training received by students in industrial hygiene programs. The results suggest that while there is uniformity in the topic areas taught, there is no uniformity in the number of hours devoted to each topic. Insufficient data was received to answer the second objective of this study, the assessment of the subject sub-topics taught. It is the author's opinion that the suggested results would have been similar even if a larger response to the questionnaire had been received. It is doubtful that other respondents would have answered class hour data in any greater detail, and the range of total class hours taught probably would have been the same, however, the sample standard deviation would have been drawn from a larger sample and, therefore, would have been a more reliable indicator of the uniformity of the class hours taught.

VI. RECOMMENDATIONS FOR INDUSTRIAL HYGIENE DEGREE PROGRAM

The efforts of this investigation would not be complete unless an attempt was made to recommend the subject matter taught

in an industrial hygiene degree program. Therefore, Tables XIII, XIV, and XV have been developed from the data received from the questionnaire respondents and previously discussed. Even though there was a limited response to the questionnaire, I believed it was strong enough to suggest the major topic areas to be taught.

Table XIII is a list of recommended Baccalaureate degree core courses. This list was developed from Table IX where the majority of respondents indicated these are the courses they teach and because it appears that a strong background in the physical sciences is required for those admitted to a Master's degree program. The courses of calculus, technical report writing, and industrial operations and systems analysis were also included on this list, even though not taught by the majority of the respondents, because the personal experience of the author and others queried at the University of Pittsburgh suggests they will be useful in several of the industrial hygiene topics. A profile of class hours or credit units was not indicated because the questionnaire respondents did not supply sufficient data.

Table XIII, on the profile of class hours taught in industrial hygiene topics is based entirely on the respondent's indications summarized in Table XI. The topics listed are those taught by the majority of the respondents. I recommend that all of these topics currently be included in both undergraduate and graduate professional Industrial Hygiene degree programs to ensure knowledge of all facets of this career field. The class hours listed were chosen by comparing the mean, mode, and range of class hours currently taught by the respondents. If all the

TABLE XIII

RECOMMENDED BACCALAUREATE CORE COURSES

Algebra
Analytical Geometry
Calculus

General Chemistry
Organic Chemistry

General Physics

Biology

English
Communication/Speech
Technical Report Writing
Social Sciences and the Humanities

Industrial Operations and Systems Analysis

topics listed in Table XIV were taught, as recommended, for the number of hours listed; a Baccalaureate degree would require approximately 38 units of Industrial Hygiene credits and a Master's degree approximately 51 units. Because insufficient data was received on Baccalaureate core course requirements, a determination cannot be made to ensure that these 38 units are consistent with the current average total program requirement of 129 units. However, the 51 units are inconsistent with the current Master's degree average total program requirement of 33 units. No allowance was made for the fact that classroom hours in a laboratory class are usually given less credit because they involve a mixture of lecture, demonstration, experimentation, and problem solving. This suggests the possibility that the length of Master's degree programs in Industrial Hygiene should be extended to two years with a corresponding increase in the number of units required. I do not wish to make recommendations on the length of Master's degree programs, or on the number of class hours to be taught in each topic, because every academic institution must make these decisions based on their human, materiel and monetary resources. However, I do recommend that each of the listed topics be taught in sufficient depth and in the same relative proportions of the total time as indicated by the profile.

Inspection of Table XIV shows that, if my recommendations and the class hour profile were followed, the recipient of a Baccalaureate degree in Industrial Hygiene would have almost the same knowledge as the recipient of a Master's degree. This does not provide any incentive for the Baccalaureate degree holder to

TABLE XIV

CLASS HOUR PROFILE
INDUSTRIAL HYGIENE COURSES

Topic	Bachelor's Degree	Master's Degree
Biostatistics	45	45
Epidemiology	45	45
Anatomy/Physiology	45	45
Toxicology	45	45
Ergonomics/Anthropometry	-	45
Occupational Safety and Health Law	25	45
Industrial Safety	30	45
Occupational Medicine	-	45
Radiation: Ionizing and Non-Ionizing	45	40
Noise	20	20
Respiratory Protection	5	5
Heat and Cold Stress	5	8
Air Flow Measurement and Ventilation Design	20	45
Aerosols	25	45
Aerosols, Gases, Vapors and the Respiratory Tract	25	25
Sampling, Analyses, and Equipment Calibration Laboratories	70	90
Air Pollution/Air Resources Management	45	45
Organization and Management of Industrial Hygiene Programs	25	35
Water Pollution/Water Resources Management	45	45
Estimated Total Credit Units if all Topics Taught. Assume 1 unit = 15 Class Hours	38	51

further his education but it should be realized that the current Master's degree programs, and my recommendations, are for those students without previous education in Industrial Hygiene. Eventually, the educational process would develop to where the Baccalaureate degree recipient had a general knowledge of all industrial hygiene subjects and the Master's degree recipient would be specialized in one topic such as radiation, noise, engineering controls, or laboratory analysis. This is already the process that occurs in engineering, the physical sciences, and the social sciences; and should it happen in industrial hygiene then the recommendations made here would have to change.

Table XV, on additional background courses, was developed because the personal experience of the author and others queried at the University of Pittsburgh suggests that these courses will be helpful in understanding the theories behind the applied science used in industrial hygiene courses. These courses should not be considered as a background requirement but should only be taken if the student has an interest to go beyond the basic requirements listed in Tables XIII and XIV. Statistics will make it easier to understand Biostatistics. Differential Equations will help if the mathematical derivations of Aerosol Physics are explained. Computer Science was included because so much of today's data compilation, storage, and retrieval is done on computers. Physical and Analytical Chemistry will help in the laboratory courses. Microbiology will be useful in Epidemiology, Anatomy, Physiology, Toxicology, and Water Pollution courses.

TABLE XV

ADDITIONAL BACKGROUND COURSES

Statistics

Computer Science

Differential Equations

Physical Chemistry

Analytical Chemistry

Microbiology

Fluid Dynamics

Thermodynamics

Fluid Dynamics and Thermodynamics will make the understanding of Aerosols and Ventilation easier.

VII. SUGGESTIONS FOR FUTURE WORK

When the telephone follow-up to ensure receipt of the questionnaire was made, many of the individuals commented that the detailed questionnaire would require too much time to complete. They also indicated that they would not devote the time necessary since many of the institution's professors were busy with other projects, administrative duties, moving offices, or working in industry for the summer. It should be noted that the questionnaire was mailed out in the middle of June at a time when many institutions were already on a summer session schedule. In addition, the questionnaires that were returned only indicated the number of hours taught for the major topica area with no hours listed for the sub-topics. Usually no indication was made of which sub-topics were taught. This would also indicate the questionnaire was too long and too detailed. There was some confusion concerning what was meant by "class hours" since several respondents listed credit units for a particular topic and some listed both credit units and hours taught.

The complete questionnaire was sixteen pages long with the first four pages containing fill-in blanks for admission and graduation requirements. The last 12 pages concerned the detailed subject matter. The first four pages were filled out by all respondents but not all respondents filled out the remainder of

the questionnaire. One respondent sent catalogue data and replied "see attached," however, I was unable to make a determination as to which classes were required for a degree, if the classe fit into the questionnaire topic areas, or how many class hours wer taught in each topic.

From the above comments, I conclude that my questionnaire was too long and too detailed. It may have been sent too late in the academic year, and possibly did not allow enough time for completion and return.

If the following improvements or changes in the questionnaire or procedures were made there would probably be a higher percentage of returns.

a) Retain the present questionnaire format, with two exceptions, but ask only for the hours taught under the major topic area, with a taught/not taught indication by each sub-topic.

b) Delete the questionnaire section on the names and qualifications of the professors because it is not needed to assess subject matter taught; and delete the section on accreditation because a questionnaire of this type cannot adequately assess the opinions of all those involved in industrial hygiene.

c) Mail the questionnaire earlier in the academic year and allow more time for completion and return.

d) Completely explain the need for the survey in the cover letter to gain the recipient's attention and cooperation. Also, use both a letter follow-up along with a telephone follow-up to ensure receipt and encourage completion and return.

Because insufficient data was received relating to subject matter taught in industrial hygiene topics, further investigations

of this matter should be conducted. More information in this area may provide valuable information and more insight into the uniformity among institutions offering industrial hygiene degree programs. It may also enable the investigator to recommend an accreditation criteria.

One other line of investigation that may also help in this area would be to develop a questionnaire to be sent to industry to assess what they desire in, and what their needs are for, industrial hygienists they hire. In this manner the demands of industry could be compared with the supply from academic institutions to further ensure that industrial hygiene students are being properly trained for the work they will perform.

Additionally, the assessment of the opinions on accreditation of professional industrial hygiene degree programs is not complete. Because these are personal opinions and this questionnaire only had eleven returns, a separate questionnaire on the needs and goals of an accreditation criteria/procedure should be developed. This questionnaire could then be sent to members of the AIHA and American Conference of Governmental Industrial Hygienists, each professor and instructor teaching industrial hygiene in colleges and universities, and to other industrial hygienists working in industry.

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APPENDIX 1

COVER LETTERS AND QUESTIONNAIRE

University of Pittsburgh

GRADUATE SCHOOL OF PUBLIC HEALTH
Department of Industrial Environmental Health Sciences

June 4, 1979

Dr. John Frohliger
Department of Industrial
Environmental Health Sciences
Graduate School of Public Health
University of Pittsburgh
Pittsburgh, PA 15261

Dear Dr. Frohliger:

As a candidate for a Master of Science degree in Industrial Hygiene at the University of Pittsburgh, I am investigating the subject "Current Status of Professional Industrial Hygiene Programs in the USA." The enclosed questionnaire is aimed at surveying Bachelor and Master level degree programs in Industrial Hygiene. Your assistance is solicited to complete the attached questionnaire and return it to me.

The questionnaire examines topics usually included in Industrial Hygiene programs. However, if an area you teach is not included, please indicate the course, topics treated and associated teaching hours. Also, please include any catalogues or course outlines you think will be useful in the survey.

The term "Coursework" as used in the questionnaire refers to not only entire courses in the subject area, but also to portions of topics that may be taught for understanding of a different area. For example, the anatomy of the lung may be presented in a class on the health effects of aerosols.

Thank you for your assistance.

Sincerely,

Denton R. Crotchett

DRC/mh
enclosure

PITTSBURGH, PA. 15261

University of Pittsburgh

GRADUATE SCHOOL OF PUBLIC HEALTH
Department of Industrial Environmental Health Sciences

June 7, 1979

To Recipients of Industrial Hygiene Education Questionnaire

I am appealing to you to give the enclosed questionnaire the attention it requires. With the recent rapid expansion in educational effort in Industrial Hygiene in the U.S., there is an urgent need to determine what subject matter is being offered to students. As a profession we should soon recommend core subject matter for I.H. programs. This questionnaire is a first step in this direction.

We will prepare a summary document based on returns and will send copies to all respondents to this questionnaire.

Thank you for your cooperation.

Sincerely,

Morton Corn

Morton Corn, Ph.D.
Professor

MC:jmd
Enclosure

PITTSBURGH, PA 15261 (412) 624-3113

INDUSTRIAL HYGIENE PROFESSIONAL DEGREE PROGRAM SURVEY

I. NAME OF INSTITUTION:

II. NAME OF COLLEGE, SCHOOL, DIVISION, AND/OR DEPARTMENT:

III. MAILING ADDRESS:

IV. NAMES, TITLES, AND QUALIFICATIONS OF ALL PROFESSORS, ASSISTANT PROFESSORS, AND INSTRUCTORS TEACHING INDUSTRIAL HYGIENE COURSES:

Name	Title	Qualifications (Degrees, Experience)

V. TYPE ACADEMIC YEAR: SEMESTERS____TRIMESTERS____QUARTERS____

VI. DEGREES GRANTED IN INDUSTRIAL HYGIENE:

B.S._____ M.S._____ MPH_____ Others (Specify)_____

VII. REQUIREMENTS FOR ADMISSION:

A. BACHELOR LEVEL DEGREE

1. High School GPA Minimum_____
2. Sat Minimum Score_____ or
   Equivalent Test (Specify) Score_____

B. MASTER LEVEL DEGREE

1. Undergraduate GPA Minimum_____
2. GRE Minimum Score_____ or
   Equivalent Test (Specify) Score_____
3. Previous Degree in:

   a. Engineering

   (1) Any_____ (5) Mechanical_____
   (2) Industrial_____ (6) Chemical_____
   (3) Civil_____ (7) Biomedical_____
   (4) Electrical_____ (8) Other (Specify)_____

   b. Chemistry_____
   c. Biology_____
   d. Physics_____
   e. Pre-Medical_____
   f. M.D._____
   g. Other (Specify)_____

4. Of the above degrees, which is preferred?
   State preference and reason.

5. Percentage of Personnel in Program with Degree in:

   Engineering_____ Physics_____
   Chemistry_____ Other_____
   Biology_____

VIII. REQUIREMENTS FOR GRADUATION:

A. Total units required: Masters_____ Bachelors_____
B. Time required to complete coursework: Masters_____
   Bachelors_____ (Yrs)
C. Design Project required?

   1. Masters Level: Yes_____ No_____
   2. Bachelors Level: Yes_____ No_____

D. Essay/Thesis required?

   1. Masters: Yes_____ No_____
   2. Bachelors: Yes_____ No_____

E. Is report writing required as a separate course or
   is it incorporated into other coursework?

   1. Masters: Separate____ Incorporated____ Both____
   2. Bachelors: Separate____ Incorporated____ Both____

IX. ACADEMIC EXPERIENCE REQUIRED FOR ADMISSION TO MASTERS PROGRAM OR UNDERGRADUATE COURSEWORK REQUIRED FOR BACHELORS DEGREE:

Topic	Masters		Bachelors		
	Yes	No	Yes	No	Class Hours
A. Mathematics					
1. Algebra					
2. Analytical Geometry					
3. Calculus					
4. Advanced Calculus					
5. Differential Equations					
6. Probability Theory					
7. Statistics					
8. Numerical Analysis					
9. Complex Variables					
10. Linear Algebra					
11. Vector Analysis					
12. Computer Science					
B. Engineering					
1. Material Science					
2. Mechanics of Materials					
3. Statics					
4. Dynamics					
5. Fluid Mechanics					
6. Thermodynamics					
7. Introduction to Electrical Circuits					
8. Drafting/Graphics					
9. Engineering Economy					
10. Systems Analysis					
11. Environmental Engineering					
12. Industrial Operations					
13. Human Factors Engineering					
14. Decision Making					
15. Operations Analysis & Control					
C. Chemistry					
1. General					
(a) College level					
(b) Other					
2. Organic					
3. Physical					
4. Analytical					
5. Biochemistry					

D. Physics

1. General

(a) College level
(b) Other

E. Biology
F. Microbiology
G. Anatomy
H. Physiology
I. English
J. Speech
K. Report Writing
L. Social Sciences
M. Psychology
N. Humanities
O. Economics

X. SPECIFIC INDUSTRIAL HYGIENE COURSEWORK REQUIRED FOR EITHER MASTERS OR BACHELORS DEGREE

	Bachelors			Masters			
	Optional	Req'd	Not Taught	Optional	Req'd	Not Taught	If Taug See Pag
A. Biostatistics							5
B. Epidemiology							5
C. Anatomy/Physiology							6
D. Toxicology							6
E. Ergonomics/Anthropometry							7
F. Occupational Safety and Health Law							7
G. Industrial Safety							8
H. Occupational Medicine							8
I. Ionizing Radiation							9
J. Non-Ionizing Radiation							9
K. Radiation Health							9
L. Radiation Protection							9
M. Lighting							9
N. Noise							9
O. Noise Measurement							9
P. Noise Reduction							9
Q. Hearing Conservation							9
R. Respiratory Protection							10
S. Heat and Cold Stress							10
T. Air Flow Measurement							10
U. Ventilation Design							11
V. Aerosols							11
W. Aerosols, Gases, Vapors and the Respiratory Tract							12

	Bachelors			Masters			
	Optional	Req'd	Not Taught	Optional	Req'd	Not Taught	If Taught See Page
X. Sampling Laboratory							13
Y. Analysis Laboratory							14
Z. Equipment Calibration Laboratory							14
AA. Air Pollution/Air Resources Management							15
BB. Water Pollution/Water Resources Management							15
CC. Industrial Hygiene Program Organization and Management							16

XI. BIOSTATISTICS

	Class Hours	
	Bachelors	Masters
A. Probability Theory		
B. Conditional Probability		
C. Density Functions (General)		
D. Distribution Functions (General)		
E. Measure of Central Tendency		
F. Distributions:		
1. Binomial		
2. Hypergeometric		
3. Poisson		
4. Normal		
5. Log-Normal		
6. Student's t		
7. Chi Square		
G. Sampling		
H. Confidence Intervals/Limits		
I. Hypothesis Testing		
1. Alpha/Type I Error		
2. Beta/Type II Error		
3. Two Sample		
4. Proportions		
5. Contingency Tables		
6. Chi-Square Goodness of Fit		
7. Non-Parametric		
8. One Way Analysis of Variance		
9. Two Way Analysis of Variance		
10. Regression and Correlation		

XII. EPIDEMIOLOGY

A. Overview of Epidemiology		
B. Disease Prevention		
C. Rates, Ratios, Statistics, and Data Presentation		

	Class Hours	
	Bachelors	Masters
D. Host Characteristics		
E. Agent Characteristics		
F. Environmental Characteristics		
G. Epidemics		
H. Temporal Trends		
I. Design of Epidemiological Studies		
J. Clinical Trials		
K. Measurement of Risk		
L. Evaluation of Cause-Effect Evidence		
XIII. ANATOMY/PHYSIOLOGY		
A. Medical Terminology		
B. Cells		
C. Tissue		
D. Sketal Structure		
E. Muscle Structure		
F. Cardio-Vascular System		
G. Respiratory Tract System		
H. Gastro-Intestinal Tract System		
I. Brain and Central Nervous System		
J. Lymphatic System		
K. Reproductive Systems		
L. Liver		
M. Kidney		
N. Pancreas		
O. Spleen		
P. Gall Bladder		
Q. Skin		
R. Sensory Systems		
S. Body Temperature Regulation		
T. Tumors		
U. Genetics		
V. Defenses Against Disease		
XIV. TOXICOLOGY		
A. Theoretical Toxicology		
1. Biology Review		
2. Chemistry Review		
3. Dose-Response Relationship		
4. Types of Response		
5. Routes of Entry		
6. Transportation within Body		
7. Biotransformation		
8. Storage within Body		
9. Elimination from Body		
10. Individual Variation		
11. Joint Toxicity		
12. Selective Toxicity		
13. Review of Statistics		

	Class Hours	
	Bachelors	Masters
B. Experimental Toxicology		
1. Animal and Human Experiments		
2. Quantitative Tests		
3. Qualitative Tests		
4. Extrapolation to Man		
C. Regulatory Controls		
1. History		
2. Food Additives		
3. Pesticides		
4. Drugs		
5. Cosmetics		
6. Industrial Usage		
7. Shipping/Transportation		
8. Emergencies/Spills		
9. Laboratories		
D. Descriptive Toxicology		
1. Establishing MAC's/TLV's/PEL's		
2. Hydrocarbons		
3. Sulfur Compounds		
4. Organophorous Compounds		
5. Nitrogen Compounds		
6. Halogen Compounds		
7. Other Organic Compounds		
8. Organometallic Compounds		
9. Metallic Dusts, Fumes, Gases		
10. Non-Metallic Dusts, Fumes, Vapors		
11. Fibrous Materials		
12. Hydrides		
13. Other Non-Metallic Particulates		
XV. ERGONOMICS/ANTHROPOMETRY		
A. Anthropometry		
B. Biomechanics		
C. Static Work		
D. Dynamic Work		
E. Shift Work and Biological Rythms		
F. Information Processing		
G. Ergonomics of Respirators		
XVI. OCCUPATIONAL SAFETY AND HEALTH LAW		
A. History		
B. Overview of Occupation Safety and Health Act of 1970		
C. General Duty Clause		
D. Standards		

		Class Hours	
		Bachelors	Masters
	E. Inspections and Investigations		
	F. Violations, Citations, and Penalties		
	G. Administrative and Judicial Review		
	H. Record Keeping, Reports, Surveys		
	I. Research and Training		
	J. Role of States		
	K. Review of Clean Air Act		
	L. Review of Toxic Substances Control Act		
	M. Review of Other Statutes		
XVII.	INDUSTRIAL SAFETY		
	A. History		
	B. Safety Hazards		
	C. Safety Protection Devices		
	D. Personal Protective Equipment		
	E. Safety Control Procedures		
	F. Fire Hazards, Prevention and Protection		
	G. Job Safety Training		
	H. Job Safety Observation		
	I. Job Safety Inspection		
	J. Accident Investigation		
	K. Management's Role in Safety		
	L. Industrial Safety Programs		
	M. Records and Statistics		
	N. Human Behavior and Psychological Factors		
	O. Emergencies		
	P. Workmen's Compensation		
XVIII.	OCCUPATIONAL MEDICINE		
	A. Diseases and Their Causes		
	1. Pneumoconioses		
	2. Asthma and Bronchitis		
	3. Liver Diseases		
	4. Skin Diseases		
	5. Bone Diseases		
	6. Cancers and Tumors		
	7. Central Nervous System Disorders		
	8. Reproductive System Disorders		
	9. Kidney Diseases		
	10. Sensitization and Allergic Response		

	Class Hours	
	Bachelors	Masters
B. Medical Tests and Examinations		
1. Pre-Employment, Periodic, and Termination Examinations		
2. Pulmonary Function Tests		
3. Liver Function Tests		
4. Kidney Function Tests		
5. Blood Tests		
6. Urine Tests		
7. X-Rays		
C. Early Detection		
D. Medical Surveillance		
E. Industrial Medical Programs		
F. Workmen's Compensation		
XIX. RADIATION		
A. Ionizing Radiation		
1. Types, Sources, Decay, and Interaction		
2. Radiation Units		
3. Biological Effects		
4. Detection and Measurements		
5. Exposure		
6. Protection Methods		
B. Design of Radiation Shielding		
C. Non-Ionizing Radiation		
1. Ultraviolet		
2. Infrared		
3. Lasers		
4. Radar, Microwave, and Radio-frequency		
XX. LIGHTING		
A. Physics of Light		
B. Effects of Lighting on Safety, Health and Productivity		
C. Measurement		
D. Recommended Task Lighting Levels		
E. Lighting Fixtures		
F. Design of Lighting Systems		
XXI. NOISE		
A. Physics of Sound		
B. Anatomy of the Ear		
C. Effects of Exposure to Noise		
D. Sound/Noise Measurement		
E. Noise Reduction Theory		
F. Noise Reduction Materials and Methods		

		Class Hours	
		Bachelors	Masters
	G. Design of Noise Reduction Systems		
	H. Hearing Conservation Programs		
XXII.	RESPIRATORY PROTECTION		
	A. Use of Respirators		
	B. Types of Respirators		
	1. Air Filtering		
	2. Supplied Air		
	3. Self Contained		
	C. Physiology Affecting Fit or Use		
	D. Choosing the Correct Respirator		
	E. Components of a Respiratory Protection Program		
	F. Government Regulation		
XIII.	HEAT AND COLD STRESS		
	A. Metabolic Heat Load		
	B. Evaporative Heat Loss		
	C. Radiation Heat Gain/Loss		
	D. Convective/Conductive Heat Gain/Loss		
	E. Physiological Response of the Body		
	F. Heat Balance Equation		
	G. Body Heat Storage/Loss		
	H. Indices of Heat Stress		
	1. Ideal		
	2. Effective Temperature		
	3. Predicted Four Hour Sweat Rate		
	4. Wet Bulb Globe Index		
	5. Heat Stress Index		
	6. Other Indices/Measurements		
	I. Wind Chill Index		
	J. Heat Injuries and Prevention of Heat Injury		
	K. Cold Injuries and Prevention of Cold Injury		
XXIV.	AIR FLOW MEASUREMENT AND VENTILATION DESIGN		
	A. Air Flow Measurement		
	1. Static, Velocity, and Total Pressure		
	2. Instruments and measurements		
	a. Hot Wire Anemometer		
	b. Heated Thermocouple Anemometer		
	c. Rotating Vane Anemometer		
	d. Swinging Vane Anemometer		
	e. Manometer		
	f. Pitot Tube and Pitot Tube Transverse		
	g. Critical Orifice		
	h. Tracer Gas		
	i. Smoke Tube		
	3. Practical Application		

	Class Hours	
	Bachelors	Masters

B. Ventilation Design

1. Review of Fluid Mechanics
2. Psychrometric Properties of Air
3. Thermodynamic Properties of Air
4. Dilution Ventilation
5. Local Exhaust Ventilation
   a. Air Flow Requirements
   b. Types of Hoods and Hood Design
   c. Free Air Jets
   d. Solid Materials Handling
   e. Hot Processes
   f. Ducting
   g. Resistance in Ventilation Systems
   h. Fans and Blowers
   i. Balancing Systems
   j. Installation
6. Make-up Air
7. Air Cleaning Devices
8. Energy Conservation
9. Comfort Ventilation Systems

XXV. AEROSOLS

A. Sources of Aerosols
B. Particle Static Properties
   1. Size
   2. Shape
   3. Density
   4. Composition
   5. Optical Properties
   6. Surface Properties
   7. Adhesion
C. Particle Dynamic Properties
   1. Equations of Motion
   2. Sedimentation
   3. Diffusion
   4. Agglomeration
   5. Electrical Mobility
   6. Thermal Mobility
   7. Evaporation/Condensation
   8. Attraction
D. Particle Collection Mechanisms
   1. Impaction
   2. Interception
   3. Diffusion
   4. Settling

	Class Hours	
	Bachelors	Masters

E. Particle Collection Devices for Sampling or Air Cleaning

1. Settling Chambers
2. Elutriators
3. Cyclones
4. Filters
5. Electrostatic Precipitators
6. Thermal Precipitators
7. Impactors
8. Scrubbers

F. Particle Counting Methods/Devices

1. Microscopy
2. Condensation Nuclei Counters
3. Optical Counters
4. Electrical Counters

G. Particle Sampling

1. Review of Statistics
2. Size Distributions
3. Error Analysis
4. Confidence Limits
5. Sampling Strategy
6. Area Sampling
7. Personal Sampling
8. Stack Sampling

H. Aerosol Generation

XXVI. AEROSOLS, GASES, VAPORS AND THE RESPIRATORY TRACT

A. Generation of Aerosols, Gases, and Vapors

B. Sizes of Aerosols, Gases, and Vapors

C. Description and Clearance Mechanisms of the Respiratory Tract

1. Naseo-Pharynx (NP) Compartment
2. Trachea-Bronchi (TB) Compartment
3. Pulmonary (P) Compartment

D. Aerosol Deposition and Associated Sizes Within the Respiratory Tract

1. NP Compartment
2. TB Compartment
3. P Compartment

	Class Hours	
	Bachelors	Masters
E. Effects of Aerosols		
1. Soluble		
2. Insoluble		
3. Diseases of the Lung		
F. Effects of Gases and Vapors		
1. Irritants		
2. Asphyxiants		
3. Volatile Drugs and Drug-Like Substances		
4. Inorganic and Organometallic Substances		
5. Equilibrium between Concentrations in the Air and the Bloodstream		
6. Elimination from the Body		
G. Sampling Instruments Simulating the Respiratory Tract		
XXVII. *SAMPLING LABORATORY*		
A. Particulate Sampling		
1. Filters		
2. Cyclones		
3. Elutriators		
4. High Volume		
5. Dust Cans		
6. Impingers		
7. Impactors		
8. Thermal Precipators		
9. Electrostatic Precipators		
10. Particulate Counters		
B. Gas/Vapor Sampling		
1. Charcoal Tubes		
2. Bubblers		
3. Bags and Flasks		
C. Air Movers		
1. Air Pumps		
2. Evacuated Flasks		
3. High Volume Pump		
4. Hand Pumps		
D. Sampling Strategies		
1. Personal Sampling		
2. Area Sampling		
3. Stack Sampling		

		Class Hours	
		Bachelors	Masters
XXVII.	ANALYSIS LABORATORY		
	A. Particulate Analyses		
	1. Optical Microscopy		
	2. Phase-Contrast Optical Microscopy		
	3. Electron Microscopy		
	4. Total Suspended Particulates		
	5. Size Distribution		
	B. Chemical Analyses		
	1. Wet Chemistry		
	2. Photometry		
	3. Atomic Absorption Spectrophotometry		
	4. UV Absorption Spectrophotometry		
	5. IR Absorption Spectrophotometry		
	6. Gas Chromatography		
	7. Liquid Chromatography		
	8. Ion Chromatography		
	9. Mass Spectroscopy		
	10. Radioactive Tagging		
	11. Direct Reading Colorimetric Indicators		
	12. Direct Reading Instruments		
	C. Quality Control		
	D. Error Analysis		
XXIX.	EQUIPMENT CALIBRATION LABORATORY		
	A. Calibration of Airmovers		
	B. Thermometers and Temperature Measuring Devices		
	C. Direct Reading Instruments and Indicators		
	D. Chemical Analytical Equipment		
	E. Particulate Collection and Counting Devices		
	F. Microscopy		
	G. Air Flow Measuring Equipment		
	H. Accoustical Equipment		
	I. Ionizing Radiation Measuring Equipment		
	J. Non-Ionizing Radiation Measuring Equipment		
	K. Light Meters		
	L. Error Analysis		

		Class Hours	
		Bachelors	Masters
XXX.	AIR POLLUTION/AIR RESOURCES MANAGEMENT		
	A. Physics of the Atmosphere		
	B. Chemistry of the Atmosphere		
	C. Photochemistry		
	D. Sources of Air Pollution		
	1. Dust/particulates		
	2. Hydrocarbons		
	3. Sulfur Oxides		
	4. Nitrogen Oxices		
	5. Carbon Monoxide		
	6. Oxidants		
	7. Others		
	E. Biological and Health Effects of Air Pollution		
	1. Humans		
	2. Plants		
	3. Animals		
	F. Meteorology		
	G. Air Pollution Modeling		
	H. Air Pollution Control Methods and Equipment		
	I. Economic Aspects of Air Pollution Damage and Control		
	J. Air Pollution Standards, Legislation, and Regulation		
XXXI.	WATER POLLUTION/WATER RESOURCES MANAGEMENT		
	A. Hydrological Cycle		
	B. Aquatic Biology		
	C. Sources of Water for Consumption and Use		
	D. Water Quality Criteria		
	E. Water Pollution		
	1. Pollution Sources		
	2. Oxygen Demand		
	3. Self Purification		
	F. Biological and Health Effects of Water Pollution		
	1. Humans		
	2. Plants		
	3. Animals		
	G. Supply Water Treatment		
	H. Biological Wastewater Treatment		
	I. Industrial Wastewater Treatment		
	J. Water Pollution Legislation and Regulation		

		Class Hours	
		Bachelors	Masters
XXXII.	INDUSTRIAL HYGIENE PROGRAM ORGANIZATION AND MANAGEMENT		
	A. Organizational Structures		
	B. Management Principles		
	C. Leadership Principles		
	D. Communicating and Relating with People		
	E. Industrial Hygiene, Health, and Safety Personnel		
	F. Communications between Industrial Hygiene and Other Functions		
	G. Education and Training		
	H. Laboratory Analysis: In-House vs. Contracted		
	I. Record Keeping and Reports		
	J. Budgeting		
	K. Medical Records		
	L. Work Scheduling/Planning		
	M. Disaster Preparedness/Emergency Planning		
	N. Ethical and Moral Considerations		
XXXIII.	COMMENT ON WHETHER OR NOT INDUSTRIAL HYGIENE PROGRAMS IN COLLEGES AND UNIVERSITIES SHOULD BE ACCREDITED BY AN ORGANIZATION SUCH AS THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION OR THE AMERICAN BOARD OF INDUSTRIAL HYGIENISTS.		

APPENDIX 2

SUMMARY OF RESPONSES

TABLE 1

Institution	Program[A] Responsibility	Classification of Responsibility	Professor's Qualifications (Number with Degree in)			In Favor of Accreditation?
			Masters	Doctorate	M.D.	
1. California State University, Hayward[E]	Department	Science	2	2		NC
2. California State University, Northridge	Department	Communications & Professional Studies	3	1	1	Yes
3. Central Missouri State University	School	Public Services	2	9		No
4. City University of New York, York College	Department	Health Professions	1	2		Abstain
5. East Carolina University	Department	Allied Health		2		Yes
6. The John Hopkins University	Department	Public Health		5		Yes
7. Quinnipiac College	Department	Allied Health	1	1		Yes
8. Purdue University[G]	Department	Pharmacy and Engineering				Yes
9. University of Michigan	Department	Public Health	1	2		No
10. University of North Carolina	Department	Public Health		3		Yes
11. University of Pittsburgh	Department	Public Health	1	6	1	Yes

TABLE 2

Institution	Academic Year	Degrees Granted in Industrial Hygiene	Admission Requirements			Graduation Requirements									
						Units and Years		Design Project		Essay or Thesis		Report Writing			
												Bacc.		Mast.	
			High School GPA	Undergraduate GPA	GRE Score	Bacc.	Mast.	Bacc.	Mast.	Bacc.	Mast.	Sep.	Inc.	Sep.	Inc.
1. Hayward	Quarters	B.S.	2.0[B]	-	-	134-137 (4 yrs	-	Yes	-	Yes	-	-	Yes	-	-
2. Northridge	Semesters	B.S.,M.S.	2.0[B]	3.0	50%tile	128 (4 yrs)	30 (1-2 yrs)	No	No	No	Yes	-	Yes	-	Yes
3. Missouri	Quarters	M.S.	-	2.0	NC	-	32 (1 yr)	-	No	-	No		-	Yes	-
4. New York	Semesters	B.S.	75%	-	-	NC (4 yrs)	-	No	-	No	-	-	Yes	-	-
5. E. Carolina	Semesters	B.S.	2.5	-	-	126 (4 yrs)	-	No	-	No	-	-	Yes	-	
6. Hopkins	Quarters	M.S., MHS, MPH, ScD, PhD, DPH	-	3.0	1200	-	64 (2 yrs)	-	NC	-	Yes	-	-	-	Yes
7. Quinnipiac	Semesters	B.S.	2.0	-	-	132 (4 yrs)	-	No	-	Yes	-	-	Yes	-	-
8. Purdue	Semester	B.S., M.S., Ph.D.	3.0	3.0	NC	128 (4 yrs)	33 (1,5 yrs)	No	Yes	No	Yes	Yes	-	Yes	
9. Michigan	Semesters	M.S., MPH, PhD, DPH	-	3.0	1000		36 (1-2 yrs)	-	No	-	No	-	-	Yes	-
10. N. Carolina	Semesters	M.S., MPH, MSEE, PhD	-	3.0	1100	-	30 (1 yr)	-	No	-	Yes	-	-	-	Yes
11. Pittsburgh	Trimesters	M.S., ScD	-	3.0	1150	-	37 (1-2 yrs)	-	No	-	Yes	-	-	-	Yes

TABLE 3

Institution	Admission Requirements: Master's Degree Previous Degrees Accepted														Previous Degree Preferred
	Engineering								Chem.	Biology	Physics	Pre-Med.	M.D.	Other	
	Any	Ind	Civil	Elect	Mech	Chem	Biomed	Other							
1. Hayward	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Northridge	X	-	-	-	-	-	-	-	X	X	X	X	-	-	None
3. Missouri	-	-	-	-	-	-	-	-	X	X	X	X	-	-	Chemistry & Biology
4. New York	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5. E. Carolina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6. Hopkins	-	X	X	X	X	X	X	-	X	X	X	X	-	-	Engineering
7. Quinnipiac	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8. Purdue	X	-	-	-	-	-	-	-	X	X	-	X	X	-	Biological Sciences, Engineering
9. Michigan	X	-	-	-	-	-	-	-	X	X	X	-	X	-	Chemistry or Chemical Engineering
10. N. Carolina	X	-	-	-	-	-	-	-	X	X	X	-	X	-	Chem. or Mech. Engr., Chemistry, or Physics
11. Pittsburgh	X	-	-	-	-	-	-	-	X	X	X	X	X	X	Chem. or Mech. Engr., Chemistry, Other Engr.

TABLE 4

	Percentages of Students in Program with Previous Degree in:				
Institution	Engr.	Chemistry	Biology	Physics	Other
1. Hayward	-	-	-	-	-
2. Northridge	5	5	35	5	50
3. Missouri	-	60	35	4	1
4. New York	-	-	-	-	-
5. E. Carolina	-	-	-	-	-
6. Hopkins	-	5	95	-	-
7. Quinnipiac	-	-	-	-	-
8. Purdue	10	10	70	-	10
9. Michigan	8	26	60	3	3
10. N. Carolina	NC	NC	NC	NC	NC
11. Pittsburgh	12	50	30	8	-

TABLE 5

Academic Experience Required for Admission to Master's Degree Program or For Graduation from Bachelor's Degree Program[C]

Institution	Engr.		Mathematics							Chemistry					Physics		Biology	Microbiology	Anatomy	Physiology	English	Speech	Report Writing	Social Sciences	Economics	Humanities	Psychology
	Indust. Opns.	Other	Algebra	Analytical Geometry	Calculus	Probability Theory	Statistics	Computer Science	Other	General	Organic	Physical	Anlaytical	Biochemistry	General	Other											
1. Hayward	-	-	B	-	-	-	B	-	-	B	B	B	-	-	B	-	B	B	B	B	B	B	B	-	B	B	B
2. Northridge	-	-	B M	-	-	B M	B M	-	-	B M	B M	-	-	-	B M	-	B M	B M	-	B M	B M	-	-	B M	B M	B M	-
3. Missouri	-	-	M	M	M	-	-	-	-	M	M	M	M	M	M	-	M	-	-	M	-	-	M	-	-	-	-
4. New York	B	-	B	B	B	B	B	E	-	B	E	E	-	E	B	-	B	B	B	B	B	B	B	B	B	B	B
5. E. Carolina	-	-	B	-	-	-	-	-	-	B	-	-	-	-	B	-	B	B	B	B	B	B	-	B	B	B	-
6. Hopkins	-	-	M	M	M	-	-	-	-	M	M	-	M	D	M	-	-	M	-	-	M	-	-	D	D	D	D
7. Quinnipiac	B	-	B	B	-	-	B	-	-	B	B	-	-	B	B	-	-	-	B	B	B	B	-	B	B	B	-
8. Purdue																											
9. Michigan	-	-	M	-	M	-	-	-	-	M	M	-	-	-	M	-	-	-	-	-	-	-	-	-	-	-	-
10. N. Carolina	-	-	M	M	M	-	-	-	-	M	M	D	M	-	M	D	-	-	-	-	-	-	-	-	-	-	-
11. Pittsburgh	-	-	M	M	M	-	-	-	D	M	D	D	D	D	M	-	M	-	-	-	-	-	-	-	-	-	-

TABLE 6

Industrial Hygiene Course Work: Optional and Required Classes with Hours Taught

Institution	Biostatistics	Epidemiology	Anatomy/Physiology	Toxicology	Ergonomics/Anthropometry	Occupational Safety and Health Law	Industrial Safety	Occupational Medicine	Radiation	Lighting	Noise	Respiratory Protection	Heat and Cold Stress	Air Flow Measurement and Ventilation Design	Aerosols	Aerosols, Gases, Vapors and The Respiratory Tract	Sampling, Analyses, and Equipment Calibration Laboratories	Air Pollution/Air Resources Management	Water Pollution/Water Resources Management	Organization and Management of Industrial Hygiene Programs
1. Hayward[E]	RB	RB	RB	RB	NC	RB	RB	NT	OB	RB	RB	RB	RB	RB	RB	RB	RB	NT	NT	RB
2. Northridge	RB45 RM45	RB45 RM45	RB45 RM45	RB45 RM45	NT	RB45 RM45	RB45 RM45	NT	RB51 RM51	RB6 RM6	RB6 RM6	RB6 RM6	RB4 RM4	RB6 RM6	RB30 RM30	RB15 RM15	RB90 RM90	RB45 RM45	OB45 OM45	NT[B] RM75
3. Missouri	RM TNI	OM TNI	RM135	RM45	RM45	RM45	RM75	RM45	←	—	RM75	—	→	RM45	RM45	RM45	OM90	RM45	RM45	RM45
4. New York	RB45	RB45	RB45	RB45	NT	RB45	→	NT	←	—	—	—	RB90	—	—	→	TNI	RB45	RB90	RB45
5. E. Carolina	RB45	RB30	RB60	RB2	RB3	RB3	RB15	RB3	RB45	RB2	RB3	RB1	RB2	RB2[F]	RB2	RB2	RB18	RB45	RB45	RB2
6. Hopkins	RM70	RM33	RM60	RM48	NT	NT	RM30	RM40	OM72	RM4	RM8	RM4	RM8	RM40	RM72	RM48	RM128	RM6	OM102	RM32
7. Quinnipiac	RB45	RB45	RB45	RB45	NT	RB30	RB30	TNI	RB45	RB5	RB45	RB10	RB10	RB45	RB45	RB45	RB110	RB45	OB45	RB30
8. Purdue																				
9. Michigan	RM45	RM45	RM45	RM30	OM45	OM30	RM45	NT	OM34	RM1	RM30	RM3	RM6	RM45	RM26	RM14	RM197	RM45	OM50	RM4
10. N. Carolina	RM45	RM45	RM22	RM22	OM30	OM45	OM30	OM45	OM3	NT	OM TNI	OM3	OM3	OM45	OM75	OM10	RM60	RM45	OM34	RM10
11. Pittsburgh	RM30	RM60	RM7	RM36	RM27	RM24	RM16	RM16	RM21	NT	RM31	NT	RM8	RM33	RM50	RM6	RM68	RM45	NT	RM25

NOTES FOR APPENDIX 2:

A. Assumed Hierarchy of Program Responsibility

University
College or School
Department
Division
Group

B. California State Colleges and Universities require a balancing of High School GPA and ACT or SAT score in accordance with a published schedule.

C. "B" indicates required course for Bachelor's degree graduation.
"E" indicates an elective course for Bachelor's degree graduation.
"M" indicates required course for admission to Master's degree graduation.
"D" indicates desirable course for admission to Master's degree program.
No indication means there is no requirement.

D. "OB" indicates an optional course at the Baccalaureate degree level.
"RB" indicates a required course at the Baccalaureate degree level.
"OM" indicates an optional course at the Master's degree level.
"RM" indicates a required course at the Master's degree level.

Example: RB45 indicates a required course at the Baccalaureate level with 45 hours of classroom instruction.

E. California State University, Hayward, did not indicate class hours taught in Industrial Hygiene topics.

F. Air Flow Measurement only.

G. Purdue University sent their catalogue and said "see attached." Data to answer questionnaire could not be extracted by the author.

NA = not applicable
NT = class not taught
TNI = class taught but hours not indicated
NC = no comment or indication

APPENDIX 3

1977 NIOSH LISTED INSTITUTIONS[1]

PROGRAMS IN OCCUPATIONAL SAFETY AND HEALTH

Arizona State University
Clemson University
Kansas State University
Montana College of Mineral Science and Technology
Pennsylvania State University
Southern Illinois University
University of Illinois at Urbana-Champaign
University of New Haven
University of Wisconsin-Madison
Utah State University

PROGRAMS IN OCCUPATIONAL SAFETY

Auburn University
California State University, Long Beach
Central Missouri State University
Central Washington State College
Cogswell College
Colorado State University
Indiana University of Pennsylvania
Madonna College
Marshall University
Memphis State University
Middle Tennessee State University
New York University
New Jersey Institute of Technology
North Carolina State University at Raleigh
Northern Illinois University
Oklahoma State University
Texas Tech University
University of Arizona
University of Dubuque
University of Miami
University of Michigan

University of Tennessee, Knoxville
University of Wisconsin-Parkside
University of Wisconsin-Platteville
University of Wisconsin-Stout
University of Wisconsin-Whitewater
West Virginia University

PROGRAMS IN INDUSTRIAL HYGIENE

California State University, Hayward
California State University, Northridge
Central Missouri State University
City University of New York, Baruch College
City University of New York, Hunter College
City University of New York, York College
Colorado State University
Columbia University
East Carolina University
George Washington University
Harvard University
Johns Hopkins University
New York University
Purdue University
Quinnipiac College
Rensselaer Polytechnic Institute
Rutgers, The State University of New Jersey
Saint Augustine's College
Temple University
Texas A&M University
Tulane University
University of California, Berkeley
University of Cincinnati
University of Illinois at the Medical Center
University of Kansas
University of Lowell
University of Michigan

University of Minnesota, Twin Cities
University of North Carolina at Chapel Hill
University of Oklahoma Health Sciences Center
University of Pittsburgh
University of Rochester
University of Washington
West Virginia University

PROGRAMS IN OCCUPATIONAL NURSING

New York University
University of Cincinnati

PROGRAMS IN OCCUPATIONAL MEDICINE

City University of New York, Mount Sinai School of Medicine
Harvard University
Kaiser Steel Corporation
University of California, Irvine
University of Cincinnati
University of Illinois at the Medical Center